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SAMPLING PLAN DEVELOPMENT IN SUPPORT OF DLA'S QUALITY ASSURANCE LABORATORY TESTING PROGRAM

September 1991

OPERATIONS RESEARCH AND ECONOMIC ANALYSIS OFFICE

DEPARTMENT OF DEFENSE
DEFENSE LOGISTICS AGENCY

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Captain Mark S. Melius, USA

DEPARTMENT OF DEFENSE
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The Defense Logistics Agency's Logistics Management Division (DLA-QL) initiated actions to improve DLA's Quality Assurance Program by establishing a program of laboratory testing. However, to effectively implement the program, statistically sound sampling plans needed to be developed. Such plans would be used by the Agency in determining appropriate sampling requirements and confidence levels of estimating material conformance levels. DLA-QL requested analytical support from DLA's Operations Research and Economic Analysis Management Support Office (DORO) in developing the required sampling plans as well as a forecasting tool which would be used in predicting the change in conformance levels over time. This report describes the methodology DORO used in developing the sampling plans and forecasting tool. An analysis of the prototype sampling plans and forecasting tool is also provided.

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DLA-LO

FOREWORD

In September 1990, the Department of Defense Inspector General (DoDIG) released its final report entitled Audit of Nonconforming Products Procured by the Defense Industrial Supply Center. In the report, the DoDIG indicated finding a high degree of items which did not conform to design specifications. The DoDIG claimed such high rates were attributed to an inadequate Department of Defense (DoD) Quality Assurance Program which "...lacked the support of a DoD policy that would use laboratory testing as a principal quality assurance tool."

Defense Logistics Agency's (DLA) Logistics Management Division, Directorate of Quality Assurance (DLA-QL) immediately initiated actions to improve DLA's Quality Assurance Program by establishing a program of laboratory testing. However, to effectively implement the program, statistically sound sampling plans needed to be developed. Such plans would be used by the Agency in determining appropriate sampling requirements and confidence levels of estimating material conformance levels.

DLA-QL requested analytical support from DLA's Operations Research and Economic Analysis Management Support Office (DLA-DORO) in developing the required sampling plans as well as a forecasting tool which would be used in predicting the change in conformance levels over time. This report describes the methodology DLA-DORO used in developing the sampling plans and forecasting tool. An analysis of the prototype sampling plans and forecasting tool is also provided.

Roger C. Roy

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Policy and Plans

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EXECUTIVE SUMMARY

Defense Logistics Agency's (DLA's) 1990 Strategic Plan (dated 19 March, 1990); Acquisition Services Objective 2-1; Task (6) called for the "use of laboratory testing to verify the quality of spare and repair parts." With that guidance, DLA's Logistics Management Division, Directorate of Quality Assurance (DLA-QL) initiated an comprehensive action plan for turning the above task into an operational reality.

As an reinforcing action, the Department of Defense Inspector General (DoDIG), in September 1990 released a report entitled Audit of NonConforming Products Procured by the Defense Industrial Supply Center which highlighted the necessity of using "... laboratory testing as a principle quality assurance tool."

At the core of DLA-QL's plan was the establishment of an Agency level program of laboratory testing. To effectively implement the testing program, statistically sound sampling procedures were needed. The task of developing these procedures was directed to DLA's Operations Research and Economic Analysis Management Support Office (DLA-DORO) by DLA-QL. This report documents the methodology used in developing the requested sampling procedures.

Development of these procedures involved a three phase process. The first phase involved developing simple random sampling plans. These plans provided DLA's four hardware centers a statistically sound approach for estimating aggregate nonconformance levels. As part of this phase, a user-friendly personal computer (PC) based model was developed. The model, entitled Sampling Assistance Model (SAM), calculates sample size requirements and confidence levels and identifies National Stock Numbers (NSNs) eligible for testing.

The second phase involved developing multi-stage, stratified sampling plans for the centers. These plans provided the centers a defensible approach for estimating nonconformance levels between DLA's six defense depots and the five Defense Contract Management Districts (DCMDs) and the centers' locally administrated contracting office. A prototype model was also developed which automated the development process of the stratified plans.

The final phase of the study involved developing procedures for forecasting the trend of nonconformance levels. The proposed approach for developing the forecasting tool was to apply the exponential smoothing adjusted for trend technique. This approach was selected because of its ease of use, minimal requirement for historical data, and predictive ability outside the range of the input data.

The above described sampling procedures have been reviewed by the DoDIG office and were found to be technically sound and appropriate for supporting the DoDIG's Audit recommendation for laboratory testing.

I. INTRODUCTION

In its quest to improve the quality of products provided to the military services, Defense Logistics Agency (DLA) embarked on a comprehensive plan for enhancing its Quality Assurance Program. Guidance for obtaining the above goal was identified in the Acquisition Services Section of DLA's Strategic Plan. Within this Plan, Objective 2 states "Develop and implement initiatives for continuously improving the quality of products and services delivered to our customers." Task 6 of this Objective called for "use of laboratory testing to verify the quality of spare and repair parts." To meet this task requirement DLA's Logistics Management Division, Directorate Quality Assurance (DLA-QL) was chartered to develop a thorough course of action to establish an Agency wide Laboratory Testing Program.

As an impetus for this program, the Department of Defense Inspector General (DoDIG), in September 1990, released a report entitled Audit of Non-conforming Products Procured by the Defense Industrial Supply Center which highlighted the need to "... use laboratory testing as a principle quality assurance tool."

To effectively implement DLA-QL's proposed testing program, statistically sound sampling procedures were required. These procedures would be used to estimate product conformance levels among the Agency's supply centers, depots, and contract management districts. DLA's Operations Research and Economic Analysis Management Support Office (DLA-DORO) was tasked ,by DLA-QL, to provide the required analytical support to develop these procedures.

II. PURPOSE

A. Develop a statistically defendable approach for determining sampling requirements as well as selecting candidate National Stock Numbers NSNs) for DLA's Laboratory Testing Program. This effort involves the development of a sampling plan.

B. Develop a forecasting tool that predicts trends in DLA's nonconformity levels.

III. OBJECTIVES

A. Develop statistically sound stratified sampling plans, with acceptable confidence limits, that accurately describes the process for calculating sample size requirements and selecting NSNs.

B. Provide a forecasting tool that uses historical laboratory testing data to project future DLA conformance levels.

C. Determine the feasibility of identifying the statistical risk associated with pooling random and non-random sampling data.

D. Identify potential benefits, in terms of cost avoidance/savings, by improving DLA's Laboratory Testing Program's sampling process.

IV. SCOPE

To develop sampling and forecasting procedures to be used at DLA's four hardware centers (Defense General Supply Center (DGSC), Defense Industrial Supply Center (DISC), Defense Electronic Supply Center (DESC), and Defense Construction Supply Center (DCSC)) in support of their laboratory testing efforts.

Sampling plans were developed to obtain conformity information about:

A. The Agency

B. The four hardware centers

C. The Defense Contract Management Districts (DCMDs) and the centers' contract administration office.

D. The DLA depots

E. Source versus destination inspections

V. ASSUMPTIONS

A. Calculated sample sizes were large enough to apply the Central Limit Theorem.

B. Sample conformance levels were assumed not to be 0 or 100 percent.

C. When identifying an appropriate forecasting tool, it was assumed that conformance levels did not contain seasonal or cyclic component.

VI. LIMITATIONS

A. The study population was limited to NSNs with technical data, normally stocked within the depots, critical or essential to weapon systems, and with procurement activity during the past 2 years.

B. Part numbered items were not considered.

C. Due to an inadequate amount of randomly obtained historical data, only a prototype stratified sampling plan and forecasting tool were developed.

D. The sampling plans developed by this study only identify NSNs to be considered for testing. Sampling plans for testing lots or individual items within the NSN are covered by MIL-STD-105E or MIL-STD-414.

VII. METHODOLOGY

A. Introduction. After reviewing the study requirements, it was determined the best approach was to conduct the study in three phases. The first phase involved development of simple random sampling plans. As part of this effort, a user friendly, personal computer (PC) based model, entitled the Sampling Assistance Model (SAM), was developed to automate the sampling calculations. Results from this sampling efforts were also to be used as input for the more complex, stratified sampling plans. Development of the stratified plans was the second phase of this study. This second phase involved developing sampling procedures for estimating nonconformance levels, at each center, for both DLA's DCMDs and depots. The final phase involved identifying an appropriate forecasting technique to predict trends in conformance levels.

B. Simple Random Sampling

1. Input Data Development

The first step was to define the testing population and construct the population data files. Separate files were developed for each hardware center. The following criteria were used to define the population and construct the data files:

a. Only stocked NSN items were considered (Duplicate NSN records were eliminated).

b. NSNs had to be associated with a weapon system and identified as being essential to its operation. (i.e., Essentiality Coded (EssC): 1, 5, 6, or 7). The highest EssC was retained.

c. NSNs had to be identified as being critical to a weapon system. (i.e., Critical Item Code = "Y").

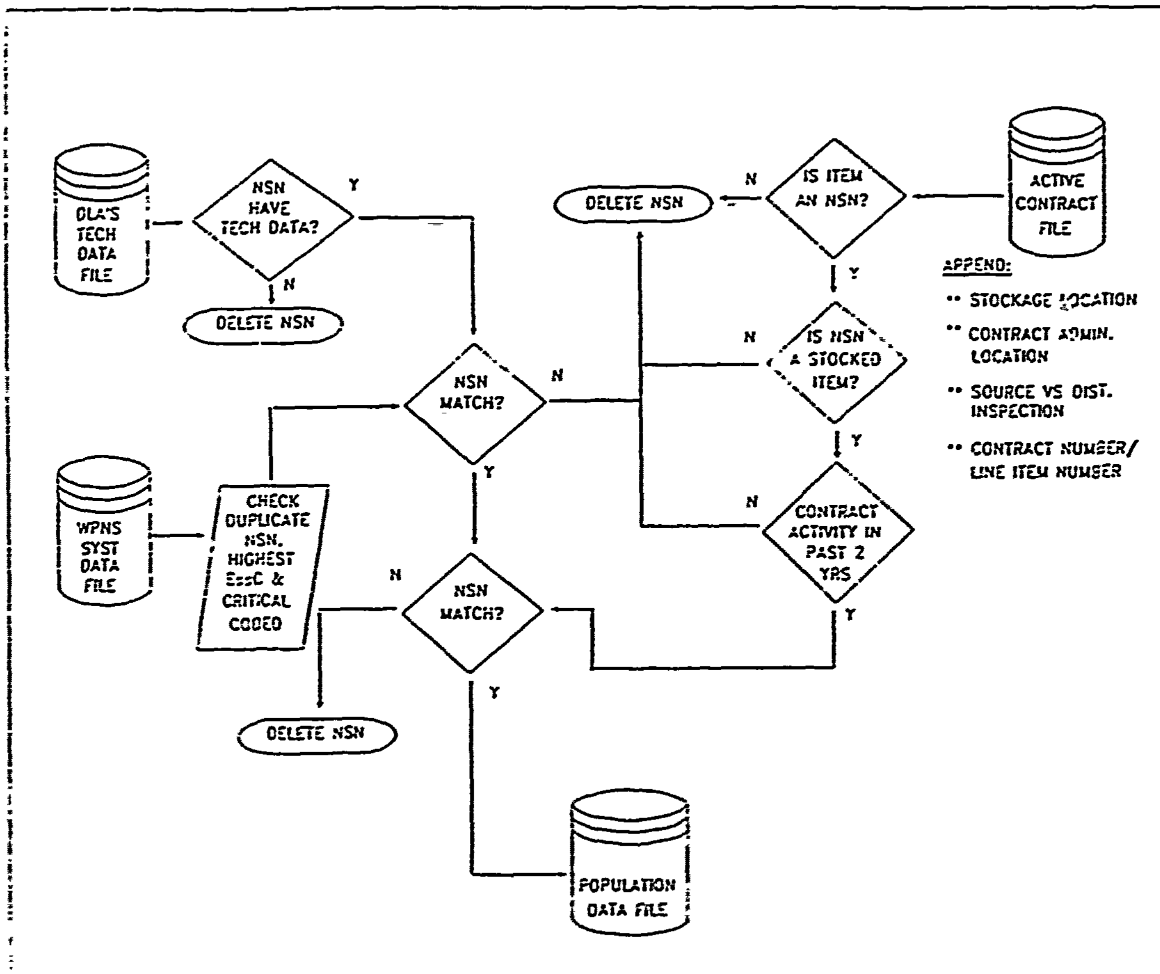
d. NSNs with procurement activity over the past 2 years (i.e., procurement Julian dates between 88365-90365).

e. NSNs with available technical data (either design drawings or specifications/standards).

Actual construction of input data files involved screening and matching NSNs based upon the above criteria. Figure 1 shows the process used in developing the input data files. Files used in this process were obtained from DLA's Integrated Data Bank.

Figure 1

PROCESS FOR CONSTRUCTING THE POPULATION DATA FILES



2. Sample Size Determination

Population proportion sampling techniques were used to determine appropriate sample size requirements. In using this approach, prior knowledge of the proportion of the population nonconforming was useful. In cases where past information was not available, it was assumed that 50 percent of the population was nonconforming. This approach did not require knowledge of the population size since sample size determination was independent of population size when using large population simple sampling techniques.

The equation used to calculate the simple sample size value was:

$$n = \frac{z^2 P(1 - P)}{e^2}$$

where

P = percent of the population nonconforming
z = standard normal deviate
e = precision level

This equation provided some degree of flexibility in determining an acceptable sample size 'n'. The two parameters which provide this flexibility were the standard normal deviate 'z' and the precision level 'e'. The standard normal deviate represented the acceptable level of confidence the user wished to obtain about how well the sampling results accurately reflect the true population nonconformance level. Corresponding z-values were obtained from a Standard Normal Distribution table. For example, a 95 percent confidence level would result in a z-value of 1.96. In SAM, confidence levels were set at either 85, 90, 95, or 99 percent.

The precision level 'e' referred to the maximum amount the point estimate (derived from the sampling process) was allowed to extend above and below the true population conformance level. In SAM, the user was allowed to enter the desired level.

3. Confidence Level Determination

In cases where resource constraints limit the size of sampling, the user may want to know the level of confidence obtained about the sample results. Confidence levels were derived by using the following equation:

$$z = \sqrt{\frac{e^2 * n}{P(1-P)}}$$

Once the z-value was calculated, confidence level values were obtainable by referring to a Standard Normal Distribution Table.

4. Random Selection of Eligible NSNs. To insure that sampling results were not biased, selection of NSNs occurred in a random manner. Randomly selecting items was an important aspect of insuring representativeness of the true population. Based on statistical principles, representativeness was a major requirement for making statistically sound inferences about the sampling population. Thus, non-random testing results should not be used in estimating a nonconformance level when the selection of the non-random samples were not representative of the true population (i.e., using non-random testing results from contractors with a history of high levels of nonconforming products).

Random selection of NSNs was accomplished for the Sampling Assistance Model (SAM) user by utilizing an internal random number generator. The selection process involved first rank ordering the population NSNs in ascending order and tagging them with a record number. Once the population size was internally determined, the random number generator produced an appropriate list of random numbers between 1 and the number of NSNs within the population. The resulting list of random numbers were then matched to the appropriate NSN record number. Associated NSN values were then appended to an output listing.

C. Stratified Sampling Process

1. Input Data Base Developed

Development of the stratified testing population was based upon the same criteria used in the simple sampling approach. However in the stratified case, duplicate NSNs were listed if the NSN was stocked at multiple DLA depots, if contracts for the NSN were administrated at multiple DCMDs, or if the NSN had multiple contract line numbers. For each NSN record, two flags were set to identify the stocking depot and contract administrating location. The location categories were:

a. By the following six DLA Depots:

(1) Defense Depot Region East (DDRE)

(2) Defense Distribution Region West (DDRW)

(3) Defense Depot Columbus (DDCO)

(4) Defense Depot Memphis (DDMT)

(5) Defense Depot Richmond (DDRV)

(6) Defense Depot Ogden (DDOU)

b. By the following five DCMDs and the hardware centers locally administered program:

(1) Local contract administration by hardware center

(2) Central

(3) Northeast

(4) Mid Atlantic

(5) South

(6) West

By using these two location flags, the population of NSN records was able to be stratified by the two activity groups. The stratified process resulted in the development of a 6 by 6 matrix (see Table 1). Each cell within the matrix represented the number of NSN records stocked at a specific depot <u>and</u> administered by a specific DCMD or local contracting office.

Table 1

DEMOGRAPHICS OF ELIGIBLE NSN RECORDS BY DEPOT & DCMD

By Frequency and Percent

				DCMD			
Depot	Local	Central	North East	Mid-Atlantic	South	West	Total
DDRE	N_{11}						ΣN_{1h}
DDRW	N_{21}						ΣN_{2h}
DDCO	N_{ih}						
DDMT							
DDRV							
DDOU							
Total	ΣN_{i1}	ΣN_{i2}			.		ΣN_{ih}

In addition to the above two flags, a third flag was included in the data file to identify if the NSN was inspected at the source (manufacturers location) or at the destination (i.e., the depot). The contract and contract line item numbers were also tagged for each NSN record.

2. Sample Size Determination

The approach used in calculating the stratified sample size was more complex than used in the simple approach. In the stratified case, the population had to be properly distributed among the various depots and the contracting administration organizations. This was accomplished by incorporating demographic information of the population into the sample size calculations. Nonconformance information about each stratum was also required.

Determination of an overall optimal sample size involved two steps. The first step involved developing stratified sample plans for each depot and contract administration location (i.e., developing a plan for each row and column of the demographic matrix). These plans were developed by using proportional stratified sampling techniques. Refer to Appendix A for a detailed description on how this technique was applied. A total of 12 plans (1 for each of the 6 DLA depots, the 5 DCMDs, and locally administered

contract office) were constructed. These plans were organized into the following two groups:

a. Six plans that defined sample size requirements for estimating DCMD and the local contracting office nonconformance levels.

b. Six plans that defined sample size requirements for estimating depot nonconformance levels.

Results from each group were then displayed in a 6 by 6 sampling matrix. These matrixes became the hardware center's plan for estimating conformance levels between either the DCMDs and local contracting office or the depots.

To obtain an overall stratified sampling plan for estimating nonconformance levels for both the contracting administration organizations and depots, a composite matrix was constructed. The construction of this matrix became the second step in determining an optimal sample size. This step involved the use of integer programming (IP) techniques and the sampling requirements obtained from the 2 stratified sampling plans developed in step 1. IP was used to optimize overall sampling requirements and accurately proportion the sampling requirements among each of the cells within the composite matrix. Refer to Appendix B for detailed discussions on the formulation of the IP problem.

D. Development of the Forecasting Model

The selected forecasting technique used in predicting the trend of nonconformance levels throughout the Agency was Exponential Smoothing Adjusted for Trend. This approach was selected because of its:

1. Ease in use.

2. Minimal requirement for historic data.

3. Predictive ability outside the range of the input data.

A detailed discussion of applying the exponential smoothing technique to sampling data is provided in Appendix C.

VIII. ANALYSIS OF RESULTS

A. Introduction. Discussions within this section focus on describing the study population, capabilities of SAM, and results of testing the prototype stratified sampling plan. DGSC data will be used for these discussions.

B. Description of Eligible Population

Based upon criteria used for identifying eligible NSNs, a testing population was defined. During the screening process, it was found the largest discriminator was the availability of technical data. Table 2 displays the percentage of NSNs within the Contract Technical Data File (CTDF) that had adequate technical data. Further analysis of DLA's Active Contract File showed this percentage improved to about 45 percent based on the value of DLA contracts over the past 2 years.

Table 2

Percent of Eligible NSNs with Adequate Technical Data
(Based on CTDF)

Hardware Center	% NSNs	% Dollar Value
DGSC	12.7	57.3
DESC	17.2	41.7
DISC	25.2	49.0
DCSC	11.6	33.1
DLA Average	16.7	45.3

Table 3 displays the eligible NSN population size when using simple random sampling techniques.

Table 3

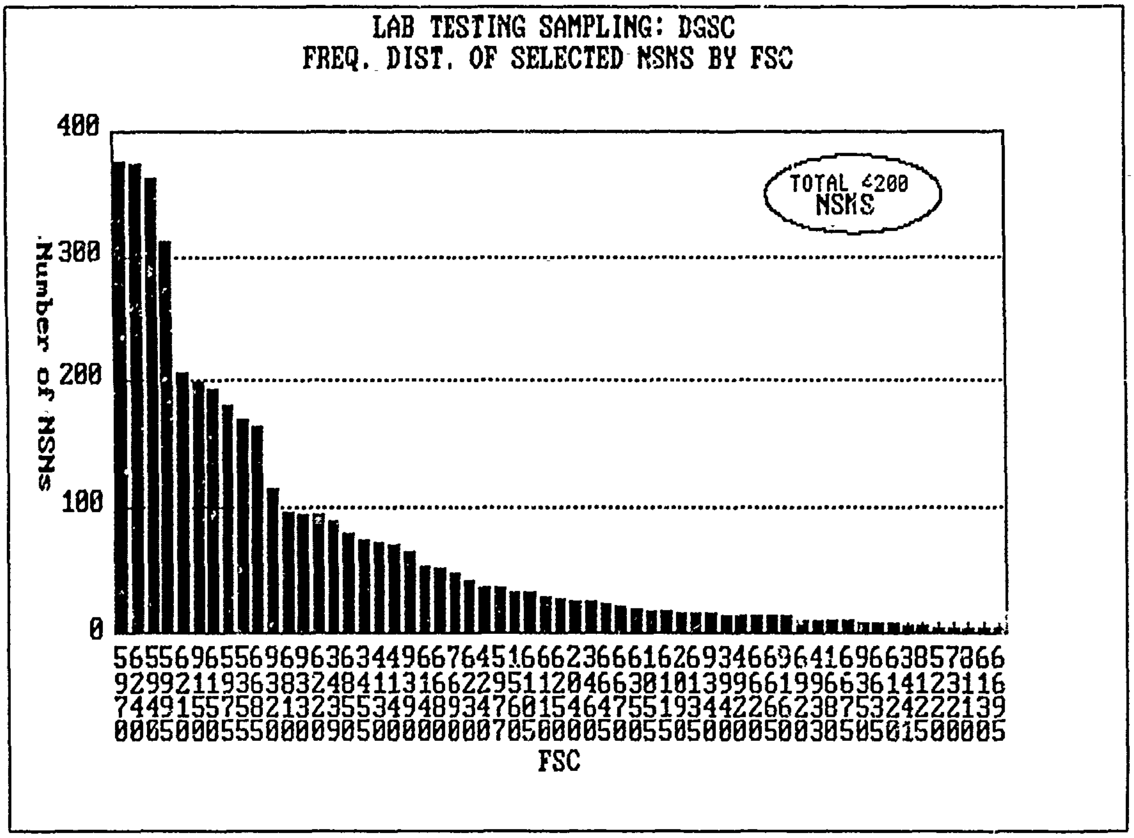
SIZE OF THE LABORATORY TESTING POPULATION
(Using Simple Random Sampling Techniques)

Hardware Center	No. of NSNs	Resulting No. of FSC's
DGSC	4,200	105
DESC	13,065	39
DISC	17,678	37
DCSC	5,006	60
DLA Totals	39,949	241

Distribution of eligible NSNs among the Federal Supply Classes (FSCs) are presented in Figure 2. The driving FSCs are easily identified. Refer to Appendix D for supporting data and charts for the other hardware centers.

For stratified sampling, the demographics of the eligible population are presented by a 6 by 6 matrix (Table 4). The rows of the matrix identify the depots and the columns identify the contract administration organization. Integer values in each cell represent the number of NSN records stocked at a specific depot and administered by a specific DCMD or center. The decimal number within the cell refers to the percentage of the cell's

Figure 2



population as compared to the overall population total. Figures in the far right column represent the eligible population totals for each depot and the bottom row represents the eligible population of each contract administration organization. The overall eligible population size was identified in the bottom, far right cell.

Table 4

DEMOGRAPHICS OF ELIGIBLE NSN RECORDS: DGSC

By Frequency and Percent

Depot	Local	Central	North East	DCMD Mid-Atlantic	South	West	Total
DDRE	778 3.62	103 0.48	202 0.94	355 1.65	90 0.42	125 0.58	1653 7.69
DDRW	1821 8.47	277 1.29	513 2.39	857 3.99	371 1.73	377 1.75	4216 19.62
DDCO	308 1.43	109 0.51	67 0.31	166 0.77	106 0.49	55 0.26	811 3.77
DDMT	1722 8.01	296 1.38	499 2.32	1100 5.12	479 2.23	466 2.17	4562 21.23
DDRV	2359 10.98	403 1.88	813 3.78	1489 6.93	643 2.99	594 2.76	6301 29.32
DDOU	1430 6.65	280 1.30	449 2.09	977 4.55	422 1.96	388 1.81	3946 18.36
Total	8418 39.17	1468 6.83	2543 11.83	4944 23.01	2111 9.82	2005 9.33	21489 100.00

The total number of NSN records that makeup the hardware centers' eligible population is provided in Table 5. Note, The population size displayed in Table 5 will be larger than the population listed in Table 3. This occurs because an NSN may be stocked at more than one depot and/or its procurement contracts may be administered by more than one contract administration organization. Refer to Appendix E for the demographic matrixes for the other hardware centers.

Table 5

STRATIFIED CANDIDATE POPULATION SIZE BY HARDWARE CENTER

Center	Population Size
DGSC	21,[illegible]
DESC	39,[illegible]
DISC	44,[illegible]
DCSC	2[illegible]
DLA Total	129,9[illegible]

C. Use of Sampling Assistance Model (SAM)

SAM is an automated simple random sampling plan for the centers. Based upon user input, the model provides information about appropriate sample size requirements, obtainable levels of confidence for a specified sample size, and an appropriate listing of randomly generated eligible NSNs. Figure 3 displays the SAM screen for calculating sampling size requirements. In this example, a nonconformance level is set at 25 percent, 95 percent confidence level, and a precision level of .05. The resulting sample size is 288 NSNs.

Figure 3

```
                LAB TESTING SAMPLING ASSISTANCE MODEL

                         SIMPLE SAMPLE SIZE


         NONCONFORMING PERCENT :   25%
         PRECISION LEVEL (+/-) :    5%
         CONFIDENCE LEVEL      :   85%    90%    95%    99%


                     SAMPLE SIZE :      288


  Hit G to generate a Random list of  288 NSNs, any other key to continue.
 ENTER to select        ESC to quit        F1 for help        ARROWS to move
```

In addition to calculating a specific sample size, SAM also provides the capability to view a range of sample sizes given various nonconformance rates, desired confidence, and precision levels. An example of this capability is shown in Figure 4. This attribute allows the user to investigate various sampling strategies in a very efficient manner. Note, sample sizes increase as nonconformance or confidence levels increase; or as precision levels tighten.

Figure 4

LAB TESTING SAMPLING ASSISTANCE MODEL

SAMPLE SIZE TABLE

CONFIDENCE LEVEL: 85% 90% $\boxed{95\%}$ 99%

Nonconform Percent	1%	2%	3%	4%	5%	6%	10%
5% (95%)	1825	456	203	114	73	51	10
10% (90%)	3457	864	384	216	138	96	35
15% (85%)	4898	1225	544	306	196	136	49
20% (80%)	6147	1537	683	384	246	171	61
25% (75%)	7203	1801	800	450	288	200	72
30% (70%)	8067	2017	896	504	323	224	81
35% (65%)	8740	2185	971	546	350	243	87
40% (60%)	9220	2305	1024	576	369	256	92
45% (55%)	9508	2377	1056	594	380	264	95
50%	9604	2401	1067	600	384	267	96

Precision Level (+/-)

ENTER to select ESC to quit F1 for help ARROWS to move

SAM also provides the user with the capability to determine confidence levels. In this case the user provides a sample size, nonconformance rate, and a desired precision level. As an example, Figure 5 displays the resulting confidence level of 75 percent for a sample size of 100, precision rate of .05, and nonconformance rate of 25 percent.

Figure 5

LAB TESTING SAMPLING ASSISTANCE MODEL

CONFIDENCE LEVEL

NONCONFORM PERCENT : 25%

PRECISION LEVEL (+/-) : 5%

SAMPLE SIZE : 100

CONFIDENCE LEVEL : 0.750

ENTER to select ESC to quit F1 for help ARROWS to move

SAM also provides the user confidence level tables to investigate various sampling strategies. This information is useful when testing resources are limited. Figure 6 displays a sample table for a precision level of +/- 5 percent. As shown by this figure, confidence levels improve as sample sizes increase and nonconformance levels decrease.

Figure 6

LAB TESTING SAMPLING ASSISTANCE MODEL

CONFIDENCE LEVEL TABLE

Precision (+/-): 1% 2% 3% 4% [5%] 6% 10%

Nonconform Percent	25	50	100	200	300	500	1000
5% (95%)	0.750	0.895	0.978	0.999	0.999	0.999	0.999
10% (90%)	0.593	0.762	0.905	0.982	0.996	0.999	0.999
15% (85%)	0.516	0.678	0.838	0.952	0.985	0.999	0.999
20% (80%)	0.465	0.621	0.789	0.923	0.970	0.995	0.999
25% (75%)	0.438	0.588	0.75[illegible]	0.897	0.954	0.990	0.999
30% (70%)	0.418	0.559	0.7[illegible]4	0.876	0.941	0.985	0.999
35% (65%)	0.397	0.541	0.7[illegible]	0.861	0.931	0.981	0.999
40% (60%)	0.390	0.520	0.692	0.850	0.923	0.977	0.999
45% (55%)	0.383	0.522	0.685	0.844	0.918	0.976	0.999
50%	0.383	0.522	0.68[illegible]	0.841	0.916	0.975	0.999

ENTER to select ESC to quit F1 for help ARROWS to move

After determining an appropriate sample size, SAM then provides the user an automated process for randomly identifying eligible NSNs for testing. This attribute reduces the chances of non-random selection of an NSN, thus reducing the possibilities of biasing sampling results. <u>The use of non-random sample results skew the estimate of conformance, thus providing an inaccurate picture of the true nonconformance level of the population</u>. Figure 7 provides an example of a randomly generated listing of 25 eligible NSNs.

Figure 7

LAB TESTING SAMPLING ASSISTANCE MODEL

RANDOM NSN LIST

4130001369191	6250002244828
4130008717147	6250002952735
5940007386272	6620005538892
5940010791936	6685009824058
5995298232833	6850000338851
5995009335793	6850002246666
6165007841251	7240000893027
6150001984600	9150005297510
6210001159152	9150006574959
6210017010074	9330004833266
6220007197086	
6240002952421	
6240005388891	
6240007272457	
6240010683899	

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D. Determination of Number of Test Specimens. Once an NSN is selected for testing, the next step is to determine the number of test specimens. The initial answer to this question is one specimen. However, if testing resources permit, the better approach is to follow the sampling procedures in MIL-STD-105E, Sampling Procedures and Tables For Inspection by Attributes, or MIL-STD-414, Sampling Procedures and Tables For Inspection By Variables For Percent Defective. If MIL-STD-105E procedures are used, it is advisable to follow the Limiting Quality sampling plans.

E. Stratified Sampling Approach

A prototype model has been developed using Lotus 123 Release 3 to test the stratified sampling plan methodology (worksheets used in calculating the results are provided in Appendix F). Under a future study effort a user-friendly, PC based program will be developed similar to SAM. In constructing the prototype model a confidence level of 95 percent and precision level of +/- .08 are used. Proxy data is used for historical sample size requirements and nonconformance levels.

Since the level of sampling information is of greater detail (i.e., obtaining conformance data about the depots and DCMDs), overall sampling requirements are much larger than simple random sampling. Sampling requirements for individual cells within the matrix are not of the same proportion as in the demographics matrix. This occurs because of differences in nonconformance levels for each cell. A higher historical rate (up to 50 percent) of nonconformance leads to a higher sampling requirement for the cell.

The process of developing an optimal stratified sampling plan involves three steps. The first step involves developing the stratified sampling plan for the DCMDs. Results of that step are shown in Table 6. In this example, DGSC is required to conduct 611 tests to make a statistical estimate of the nonconformance levels between the DCMDs. The number of samples needed from each DCMD is shown in the bottom row. In this case, one will be 95 percent confident that the sampling results represent the true nonconformance level of the eligible population.

Results from this plan can not be used to make statistical estimates of nonconformance levels between the depots. To make an estimate for the depots, a second stratified sampling is required. In this second step, a new matrix is developed using the same procedures as in the first. Results of this step are provided in Table 7.

Table 6

STRATIFIED SAMPLING PLAN
FOR DETERMINING DCMD CONFORMANCE ESTIMATES FOR DGSC
(Prototype Model)

			DCMD				
Depot	Local	Central	North East	Mid-Atlantic	South	West	Total
DDRE	9	6	9	8	5	6	43
DDRW	21	17	22	18	19	19	116
DDCO	4	7	3	4	5	3	26
DDMT	20	18	22	24	24	23	131
DDRV	28	24	35	32	33	29	181
DDOU	17	17	19	21	21	19	114
Total	99	89	110	107	107	99	611

To make estimates about nonconformance levels at the six depots, DGSC will have to conduct 572 tests. The distribution of the depot tests is shown in the far right column of the matrix. The difference between the sampling requirements in Table 6 and Table 7 is primarily attributed to different nonconformance rates and how the population is stratified between the two plans.

Table 7

STRATIFIED SAMPLING PLAN
FOR DETERMINING DEPOT CONFORMANCE ESTIMATES FOR DGSC
(Prototype Model)

			DCMD				
Depot	Local	Central	North East	Mid-Atlantic	South	West	Total
DDRE	46	6	12	21	5	7	97
DDRW	44	7	13	21	9	9	103
DDCO	39	14	8	21	13	7	102
DDMT	32	5	9	20	9	9	84
DDRV	36	6	12	23	10	9	96
DDOU	33	6	10	22	10	9	90
Total	230	44	64	128	56	50	572

To make statistical estimates about nonconformance levels for both depots and DCMDs, a third step is required. Data from Table 6 and Table 7, as well as IP techniques (see Appendix B), are used to calculate optimal sampling requirements.

Table 8 displays results of the IP effort. As shown by this table, 656 laboratory tests are required to make statistical estimates of nonconformance levels for both DLA's depots and contract administration organizations. This figure is only a 7 percent increase in the number of samples for the DCMDs and less than 13 percent for the depots.

Table 8

COMPOSITE STRATIFIED SAMPLING PLAN
FOR DETERMINING DCMD & DEPOT CONFORMANCE ESTIMATES FOR DGSC
(Prototype Model)

	DCMD						
Depot	Local	Central	North East	Mid-Atlantic	South	West	Total
DDRE	17	5	7	57	5	6	97
DDRW	21	9	34	7	13	19	103
DDCO	41	46	3	4	5	3	102
DDMT	20	9	9	8	9	29	84
DDRV	28	10	48	6	65	23	180
DDOU	17	10	9	25	10	19	90
Total	144	89	110	107	107	99	656

Notice that stratified sampling results in much higher sampling requirements than if simple random sampling techniques are used (refer to Figure 4 and Table 8). The reason for the higher stratified sampling size is the higher level of detail obtained by stratifying the population into two groups (depots and contract administration locations). If a third grouping is added, such as stratifying by Federal Supply Class (FSC), to the present stratified sampling plans, sample size requirements will increase by another order of magnitude.

F. Forecasting Nonconformance Levels

Analysis of actual forecasted nonconformance levels was not conducted in this study due to inadequate historical data. However, an example was presented to demonstrate how exponential smoothing adjusted for trend would be applied.

In the example, past sampling at a center resulted in nonconformance levels of 42 percent in 1988, 36 percent in 1989, and 31 percent in 1990. The initial estimate of expected nonconformance was 45 percent and it was estimated that nonconformance levels would be reduced by 5 percent a year through the use of laboratory testing. The smoothing constants were set at .1. The resulting forecasted levels for the next 3 years are shown in Table 9. Formulas and calculations are provided in Appendix C.

Table 9
Three Year Forecast of Nonconformance Levels

Year	Nonconformance Level
1991	25.4 %
1992	20.5 %
1993	15.5 %

IX. CONCLUSIONS

A. Development of the SAM provides the Agency with a statistically sound approach for estimating nonconformance of DLA items on an aggregate center basis.

B. A major limiting factor in developing the eligible NSN population is the availability of technical data.

C. Aggregate assessments of nonconformance can be made with relatively small sample sizes. However, these sizes will significantly increase as desired confidence and precision levels increase. Sample size requirements also increase significantly as the level of past nonconformance increases.

D. Sample size requirements significantly increase as the desired level of detail for information increases (i.e., going from obtaining nonconformity estimates about a center to obtaining estimates by center about depots and DCMDs).

E. Stratified sampling techniques are useful in estimating nonconformance levels within various sub-factors such as DLA organizations. However, the number of groups are limited when resources are considered. Sampling requirements become prohibitively large as the number of groups increase. A manageable number of activities is two (DCMDs and Depots in this effort).

F. Use of IP techniques is useful in significantly reducing sample sizes when combining stratified sampling requirements.

G. Exponential smoothing adjusted for trend is useful in predicting future nonconformance levels. However, use of this technique will first require the accumulation of adequate historical random sampling results. At least three time periods of sampling data will be required prior to being able to make a prediction on nonconformance trends throughout the Agency.

H. The use of non-random sampling results should not be used in estimating nonconformance levels if there is any doubt that the non-random samples are not representative of the population.

X. RECOMMENDATIONS

A. The SAM should be used in developing an initial assessment of nonconformity levels among the hardware centers. Randomly identified NSNs should be used in selecting items for laboratory testing. Non-random selection of NSNs will bias sampling results. Non-random testing should be used to determine the magnitude of an NSN's (or contractor) nonconformance once a problem has been identified by random testing. The non-random data should not be used in estimating nonconformance levels.

B. The stratified sampling plan should be implemented by each hardware center in estimating nonconformance levels between depots and contract administration organizations, if funds are available or if results from initial assessment by SAM indicate an unacceptable level of nonconformance.

C. The number of items to be tested within a selected NSN should be determined in accordance with MIL-STD-105E or MIL-STD-414, if testing resources permit. Initial assessments, using SAM, can be made by testing one item. If that item is found to be nonconforming, additional non-random testing should be conducted on the NSN and/or the vendor which supplied the NSN to the government.

D. Exponential smoothing adjusted for trend should be used throughout the Agency to forecast:

1. Overall nonconformance levels at a center.

2. Nonconformance levels among the DCMDs and the locally administered contracts.

3. Nonconformance levels among the DLA depots.

4. Nonconformance levels between source versus destination inspection.

E. A follow-on effort should be initiated to develop a user-friendly, PC-based, model that automates the stratified sampling plans developed by this study. This effort should include the development of an automated forecasting tool which incorporates exponential smoothing with trend techniques.

XI. POTENTIAL BENEFITS. D^velopment of simple random and stratified sampling plans provide DLA a ıtistically defensible approach for estimating nonconformance of items. Tnis effort is in direct support of DLA's Laboratory Testing Program and the DoDIG's recommendations. It is premature at this point to estimate the cost savings of identifying nonconforming items before they enter the retail supply system. However, the DoDIG reported DISC could avoid accepting about $250 million of non-issuable products by investing $10 million to $20 million over the next five years for product acceptance (laboratory) testing. Implementation of the sampling plans will provide an enormous informational value to DLA in both assessing the level of item conformity throughout the Agency and as a source for collecting quality related, performance data about contractors.

XII. DoDIG REVIEW OF METHODOLOGY. The methodology used in developing the simple and stratified sampling plans described by this report were reviewed by the DoDIG's Audit Office and were found to be technically sound and appropriate for supporting DoDIG's recommendation of establishing a laboratory testing program.

APPENDIX A

Applying Stratified Sampling Techniques

Process of Calculating Stratified Sample Size Requirements

The process of calculating the stratified sample size requirements for each depot and DCMD and local contracting office involved using the following procedures (actual application of this technique is provided in Appendix F).

1. Determine the proportion of nonconformance (P) at a DLA activity (i.e., depot or DCMD) by using the following equations:

$$P_h = \Sigma(w_{ih} * p_h)$$

where:

$$w_{ih} = \text{stratum h weight}$$

$$= \frac{N_{ih}}{N}$$

where:

N_{ih} = Total NSN Records in matrix cell ($_{ih}$)

N = Total size of population (ΣN_{ih})

and:

i = row number (depot)

h = column number (Contract Admin. Organization)

and:

p_h = nonconformance rate for stratum $_h$.

2. Determine overall stratified sample size by using the following set of equations:

$$n'_h = \frac{z^2(P_h(1-P_h))}{e^2}$$

The uncorrected sample size (n') was adjusted to account for the activity's population size. The corrected sample size was determined by the following equation:

$$n_h = \frac{n'_h}{1 + (n'/N)}$$

3. Determine stratum sample size by using the following equation:

$$n_{ih} = w_{ih} * n_h$$

4. Variance estimates were also calculated for both the stratum and the overall sample. The equations used are as follows:

Stratum Variance

$$\sigma^2_{ih} = \frac{p_h(1-p_h)}{(n_{ih} - 1)}$$

Overall Variance

$$\sigma^2_h = \Sigma \frac{w^2_{ih} \ (1 - f_{ih}) \ (p_h(1 - p_h))}{(n_{ih} - 1)}$$

where:

$$f_{ih} = n_{ih}/N_{ih}$$

APPENDIX B

Applying Integer Programming Techniques To Stratified Sampling Plans

Formulation of the Integer Programming Problem

I. <u>Introduction.</u> Formulation of the IP problem involved three steps. The objective function was first defined then the constraints were identified and constructed. Lastly, the optimal solution was determined.

II. <u>Formulating the Objective Function</u>

Since the objective was to reduce overall sampling requirements, the IP was set up as a minimization problem. Thus, the objective function was as follows:

$$\text{MIN} \quad Z = w_{11}x_{11} + w_{21}x_{21} + \ldots + w_{ih}x_{ih} + \ldots + w_{66}x_{66}$$

where the variable coefficients were defined as;

$$w_{ih} = 100*(1 / (.5 * w_i) + (.5 * w_h))$$

where;

$$w_i = \text{weight of cell ih to the row i.}$$

$$= \frac{N_{ih}}{N_{i\Sigma h}}$$

and

$$w_h = \text{weight of cell ih to the column h.}$$

$$= \frac{N_{ih}}{N_{\Sigma ih}}$$

and where the function variables were defined as;

$$x_{ij} = \text{sample size of cell } _{ih}$$

III. <u>Formulating Constraints</u>

The above objective function was then subject to the row and column constraints of the composite sampling matrix. "Right hand side" values for each constraint were obtained from the calculated sample size requirements ($n_{\Sigma i}$ or $n_{\Sigma h}$) of each of the 12 sampling plans. The exact formulation of the constraints were:

$$
\begin{aligned}
x_{11} + x_{12} + x_{13} + x_{14} + x_{15} + x_{16} &\geq n_{1\Sigma h} \\
x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} &\geq n_{2\Sigma h} \\
x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} &\geq n_{3\Sigma h} \\
x_{41} + x_{42} + x_{43} + x_{44} + x_{45} + x_{46} &\geq n_{4\Sigma h} \\
x_{51} + x_{52} + x_{53} + x_{54} + x_{55} + x_{56} &\geq n_{5\Sigma h} \\
x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} &\geq n_{6\Sigma h} \\
x_{11} + x_{21} + x_{31} + x_{41} + x_{51} + x_{61} &\geq n_{\Sigma i1} \\
x_{12} + x_{22} + x_{32} + x_{42} + x_{52} + x_{62} &\geq n_{\Sigma i2} \\
x_{13} + x_{23} + x_{33} + x_{43} + x_{53} + x_{63} &\geq n_{\Sigma i3} \\
x_{14} + x_{24} + x_{34} + x_{44} + x_{54} + x_{64} &\geq n_{\Sigma i4} \\
x_{15} + x_{25} + x_{35} + x_{45} + x_{55} + x_{65} &\geq n_{\Sigma i5} \\
x_{16} + x_{26} + x_{36} + x_{46} + x_{56} + x_{66} &\geq n_{\Sigma i6}
\end{aligned}
$$

Additional constraints were also place on each cell x_{ih}. The value for these cell constraints was the higher cell value from either the depot or the DCMD sampling plan matrixes.

IV. Solving the Integer Programming Problem

DGSC data was used to demonstrate how to apply integer programming techniques to the stratified sampling data. The first step was to calculate the coefficients for the objective functions. The value of the coefficients was based upon the candidate NSN record demographics as shown in Table B-1.

Table B-1

Example of Eligible NSN Demographics Matrix: DGSC

		DCMD							
		LOCAL	CENTRAL	NORTH-EAST	MID-ATLANTIC	SOUTH	WEST	*	TOTAL
	DDRE	778	103	202	355	90	125	*	1653
D	DDRW	1821	277	513	857	371	377	*	4216
E	DDCO	308	109	67	166	106	55	*	811
P	DDMT	1722	296	499	1100	479	466	*	4562
O	DDRV	2359	403	813	1489	643	594	*	6301
T	DDOU	1430	280	499	977	422	388	*	3946
		=====	=====	=====	=====	=====	=====	*	=====
	TOT	8418	1468	2543	4944	2111	2005	*	21489

By using the demographics information the following equation was then used to calculate the coefficient values.

CELL COEF.=100*(1/(.5*(CELL TOT./ROW TOT.) + .5*(CELL TOT./COL. TOT.))

Results from these calculations are provided in Table B-2.

Table B-2

Objective Function Coefficients

			DCMD			
	LOCAL	CENTRAL	NORTHEAST	Mid-ATLANTIC	SOUTH	WEST
DDRE	355	1510	992	698	2060	1450
DDRW	309	786	618	531	758	721
DDCO	480	959	1836	839	1105	2100
DDMT	344	750	654	431	603	598
DDRV	306	591	446	372	492	512
DDOU	376	764	689	449	652	685

Once the coefficients were defined, the formulation of the integer programming problem was possible. The formulation of integer programming problem for DGSC's optimal stratified sampling plan follows. A similar approach would be used in developing stratified sampling plans for the other hardware centers.

MIN 355 X11 + 309 X21 + 480 X31 + 344 X41 + 306 X51 + 376 X61 +
1510 X12 + 786 X22 + 959 X32 + 750 X42 + 591 X52 + 764 X62 +
992 X13 + 618 X23 + 1836 X33 + 654 X43 + 446 X53 + 689 X63 +
698 X14 + 531 X24 + 839 X34 + 431 X44 + 372 X54 + 449 X64 +
2060 X15 + 758 X25 + 1105 X35 + 603 X45 + 492 X55 + 652 X65 +
1450 X16 + 721 X26 + 2100 X36 + 598 X46 + 512 X56 + 685 X66

Constraints:

SUBJECT TO
X11 + X21 + X31 + X41 + X51 + X61 ≥ 99
X12 + X22 + X32 + X42 + X52 + X62 ≥ 89
X13 + X23 + X33 + X43 + X53 + X63 ≥ 110
X14 + X24 + X34 + X44 + X54 + X64 ≥ 107
X15 + X25 + X35 + X45 + X55 + X65 ≥ 107
X16 + X26 + X36 + X46 + X56 + X66 ≥ 99
X11 + X12 + X13 + X14 + X15 + X16 ≥ 97
X21 + X22 + X23 + X24 + X25 + X26 ≥ 103
X31 + X32 + X33 + X34 + X35 + X36 ≥ 102
X41 + X42 + X43 + X44 + X45 + X46 ≥ 84
X51 + X52 + X53 + X54 + X55 + X56 ≥ 96
X61 + X62 + X63 + X64 + X65 + X66 ≥ 90
X11 ≥ 9
X21 ≥ 21
X31 ≥ 4
X41 ≥ 20
X51 ≥ 28

Constraints continued

$X61 \geq 17$
$X12 \geq 6$
$X22 \geq 7$
$X32 \geq 7$
$X42 \geq 5$
$X52 \geq 6$
$X62 \geq 6$
$X13 \geq 9$
$X23 \geq 13$
$X33 \geq 3$
$X43 \geq 9$
$X53 \geq 12$
$X63 \geq 10$
$X14 \geq 8$
$X24 \geq 18$
$X34 \geq 4$
$X44 \geq 20$
$X54 \geq 23$
$X64 \geq 21$
$X15 \geq 5$
$X25 \geq 9$
$X35 \geq 5$
$X45 \geq 9$
$X55 \geq 10$
$X65 \geq 10$
$X16 \geq 6$
$X26 \geq 9$
$X36 \geq 3$
$X46 \geq 9$
$X56 \geq 9$
$X66 \geq 9$

In solving for an optimal feasible solution a PC-based, linear programming package was used. Results of that effort are provided in Table B-3 Table B-4 displays how the optimal solution was applied to the final composite sampling matrix. By summing the rows and columns sampling requirements were then identified for each depot, DCMD, and the center's contract administration office.

Table B-3

Optimal Feasible Solution
of Integer Programming Problem

Variable Name	Solution	Variable Name	Solution
X11	17	X14	57
X21	21	X24	7
X31	41	X34	4
X41	20	X44	8
X51	28	X54	6
X61	17	X64	24
X12	5	X15	5
X22	9	X25	13
X32	46	X35	5
X42	9	X45	9
X52	10	X55	65
X62	10	X65	10
X13	7	X16	6
X23	34	X26	19
X33	3	X36	3
X43	9	X46	29
X53	48	X56	23
X63	9	X66	19

Table B-4

STRATIFIED SAMPLING PLAN
FOR DETERMINING DCMD & DEPOT NONCONFORMANCE ESTIMATES FOR DGSC
(Prototype Model)

	DCMD						
Depot	Local	Central	North East	Mid-Atlantic	South	West	Total
DDRE	17	5	7	57	5	6	97
DDRW	21	9	34	7	13	19	103
DDCO	41	46	3	4	5	3	102
DDMT	20	9	9	8	9	29	84
DDRV	28	10	48	6	65	23	180
DDOU	17	10	9	25	10	19	90
Total	144	89	110	107	107	99	656

APPENDIX C

Forecasting Nonconformance Levels by Applying Exponential Smoothing Adjusted For Trend

I. Exponential Smoothing Adjusted for Trend Equations

The equation for exponential smoothing adjusted for trend was:

$$X_{t,T} = E(X_t) + (T*E(S_t))$$

where:

T = number of periods in the future of predictive value

t = current period

and where

$$E(X_t) = \alpha x_t + (1 - \alpha)[E(X_{(t-1)}) + E(S_{t-1}]$$

where:

$E(X_t)$ = estimated value of nonconformity of the most recent period of sampling data

α = smoothing constant (where value should not exceed .3 and the reasonable choice was .1)

x_t = observed nonconformity level obtained from sampling in period t.

$E(X_{t-1})$ = estimated value of nonconformity for the previous period.

$E(S_t)$ = estimated trend rate which is obtained by:

$$= \beta[E(X_t) - E(X_{t-1})] + (1-\beta)\ E(S_{t-1})$$

where:

β = smoothing constraint for the trend (where .1 would be reasonable choice value)

To apply the technique, at least three periods of historical data should be used. Both the smoothing constraints (α and β) need to be reviewed after analyzing several periods of forecasted data to see how well the forecasted values predicted the observed nonconformity rates.

II. An Example of Applying Exponential Smoothing to Laboratory Testing

As an example, past sampling at a center resulted in nonconformance levels of 42 percent in 1988, 36 percent in 1989, and 31 percent in 1990. The initial estimate of expected nonconformance was 45 percent and it was estimated that nonconformance levels would be reduced by 5 percent a year through the use of laboratory testing efforts. The smoothing constraints α and β were set at .1. The initial estimate of the expected nonconformance level and trend for 1988 was:

$$E(X_{1988}) = .1(42) + .9(45 - 5) = 40.2$$

The initial estimate of nonconformance was used to update the trend:

$$X(S_{1988}) = .1(40.2 - 45) - .9(5) = -4.98$$

Repeating the process for 1989 resulted in:

the expected nonconformance level of:

$$E(X_{1989}) = .1(36) + .9(40.2 - 4.98) = 35.298$$

and trend value of:

$$E(S_{1989}) = .1(35.298 - 40.2) - .9(4.98) = -4.97$$

For 1990:

the expected nonconformance level was:

$$E(X_{1990}) = .1(31) + .9(35.298 - 4.97) = 30.395$$

and trend value of:

$$E(S_{1990}) = .1(30.395 - 35.298) - .9(4.97) = -4.96$$

Thus, the forecasted nonconformance level for:

<u>1991</u> would be:

$$30.395 - 1(4.97) = \underline{25.4} \text{ percent}$$

<u>1992</u> would be :

$$30.395 - 2(4.97) = \underline{20.5} \text{ percent}$$

APPENDIX D

NSN Distribution by FSC Data

Figure D-1

LAB TESTING SAMPLING: DGSC

FREQ. DIST. OF SELECTED NSNS BY FSC

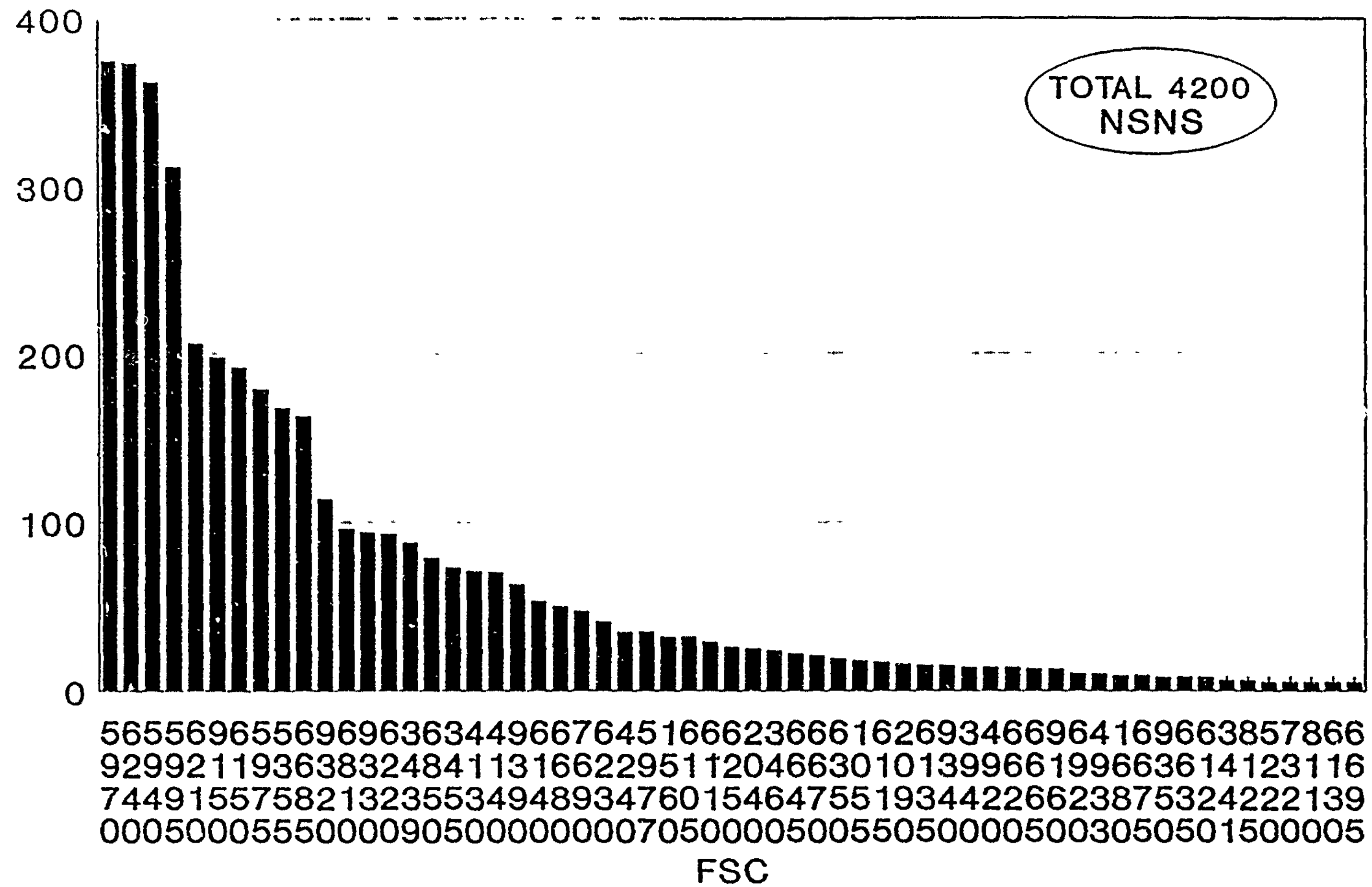

Table D-1
DLA's Laboratory Testing Program
Eligible NSN Frequency Count By Federal Supply Class (FSC): DGSC

FSC	NSN COUNT	FSC	NSN COUNT	FSC	NSN COUNT
5970	375	4933	10	3615	1
6240	374	1680	9	3610	1
5940	362	6675	9	3510	1
5995	312	9350	8	7110	1
6210	206	6635	8	8130	1
9150	198	6120	8	8140	1
6150	192	3441	6	3210	1
5975	179	8125	6	6340	1
5355	168	5220	5	6615	1
6685	163	7320	5	6940	1
9320	114	8110	5	3680	1
6810	96	6130	5	3465	1
9330	94	6695	5	2030	1
6220	93	8120	5		
3439	88	6605	5	TOTAL	4,200
6850	79	6610	5		
3455	73	6260	4		
4130	71	3433	4		
4140	70	6650	4		
9390	63	1090	4		
6140	53	3990	3		
6680	50	3456	3		
7690	47	7340	3		
6230	41	6660	3		
4240	35	3530	3		
5977	35	7240	3		
1560	32	3920	3		
6105	32	3415	2		
6110	29	6760	2		
6250	26	6730	2		
2040	25	6125	2		
3460	24	1670	2		
6645	22	6840	2		
6670	21	3413	2		
6350	19	6720	1		
1055	18	6750	1		
6115	17	6820	1		
2090	16	3444	1		
6135	15	3431	1		
9340	15	7105	1		
3940	14	6320	1		
4920	14	4925	1		
6620	14	7310	1		
6665	13	1045	1		
9160	13	4110	1		
6920	10	7360	1		

Figure D-2

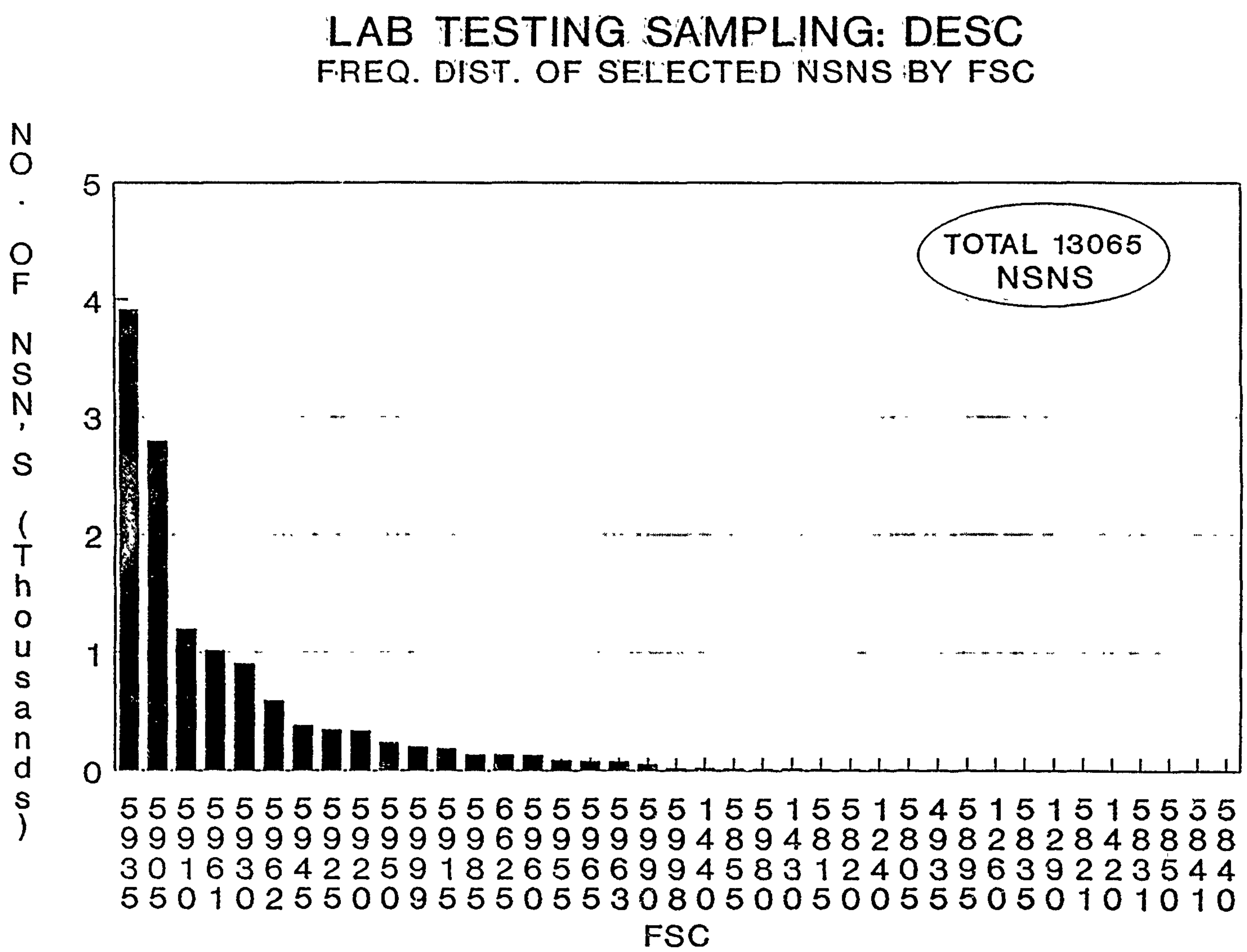
LAB TESTING SAMPLING: DESC
FREQ. DIST. OF SELECTED NSNS BY FSC
TOTAL 13065 NSNS
NO. OF NSN'S (Thousands)
0
1
2
3
4
5
5935 5905 5910 5961 5930 5962 5945 5925 5920 5950 5999 5915 5985 6625 5960 5955 5965 5963 5990 5998 1440 5855 5980 1430 5815 5820 1240 5805 4935 5895 1260 5835 1290 5821 1420 5831 5850 5841 5840
FSC

Table D-2
DLA's Laboratory Testing Program
Eligible NSN Frequency Count By Federal Supply Class (FSC): DESC

FSC	NSN COUNT
5935	3917
5905	2794
5910	1202
5961	1014
5930	907
5962	599
5945	388
5925	353
5920	343
5950	242
5999	205
5915	194
5985	140
6625	139
5960	136
5955	94
5965	78
5963	78
5990	58
5998	23
1440	23
5855	18
5980	17
1430	16
5815	15
5820	13
1240	12
5805	11
4935	10
5895	5
1260	5
5835	4
1290	3
5821	2
1420	2
5831	2
5850	1
5841	1
5840	1
TOTAL	13,065

Figure D-3

LAB TESTING SAMPLING: DISC

FREQ. DIST. OF SELECTED NSNS BY FSC

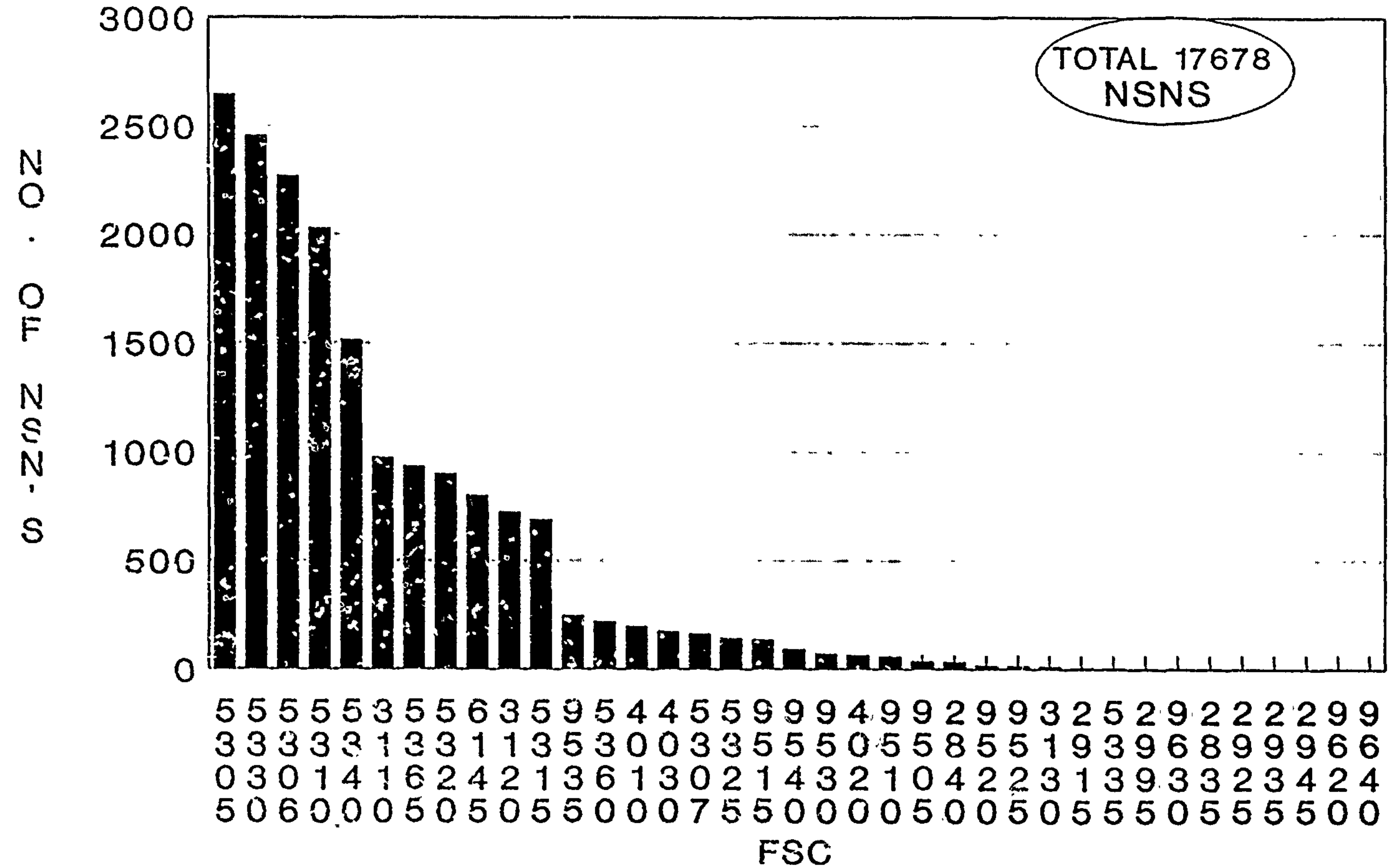

Table D-3
DLA's Laboratory Testing Program
Eligible NSN Frequency Count By Federal Supply Class (FSC): DISC

FSC	NSN COUNT
5305	2646
5330	2455
5306	2271
5310	2032
5340	1516
3110	977
5365	934
5320	900
6145	802
3120	725
5315	691
9535	247
5360	220
4010	199
4030	174
5307	163
5325	145
9515	136
9540	95
9530	75
4020	66
9510	62
9505	37
2840	35
9520	18
9525	16
3130	14
2915	8
5335	6
2995	3
9630	3
2835	2
2925	1
2935	1
2945	1
9620	1
9640	1
TOTAL	17,678

Figure D-4

LAB TESTING SAMPLING: DCSC

FREQ. DIST. OF SELECTED NSNS BY FSC

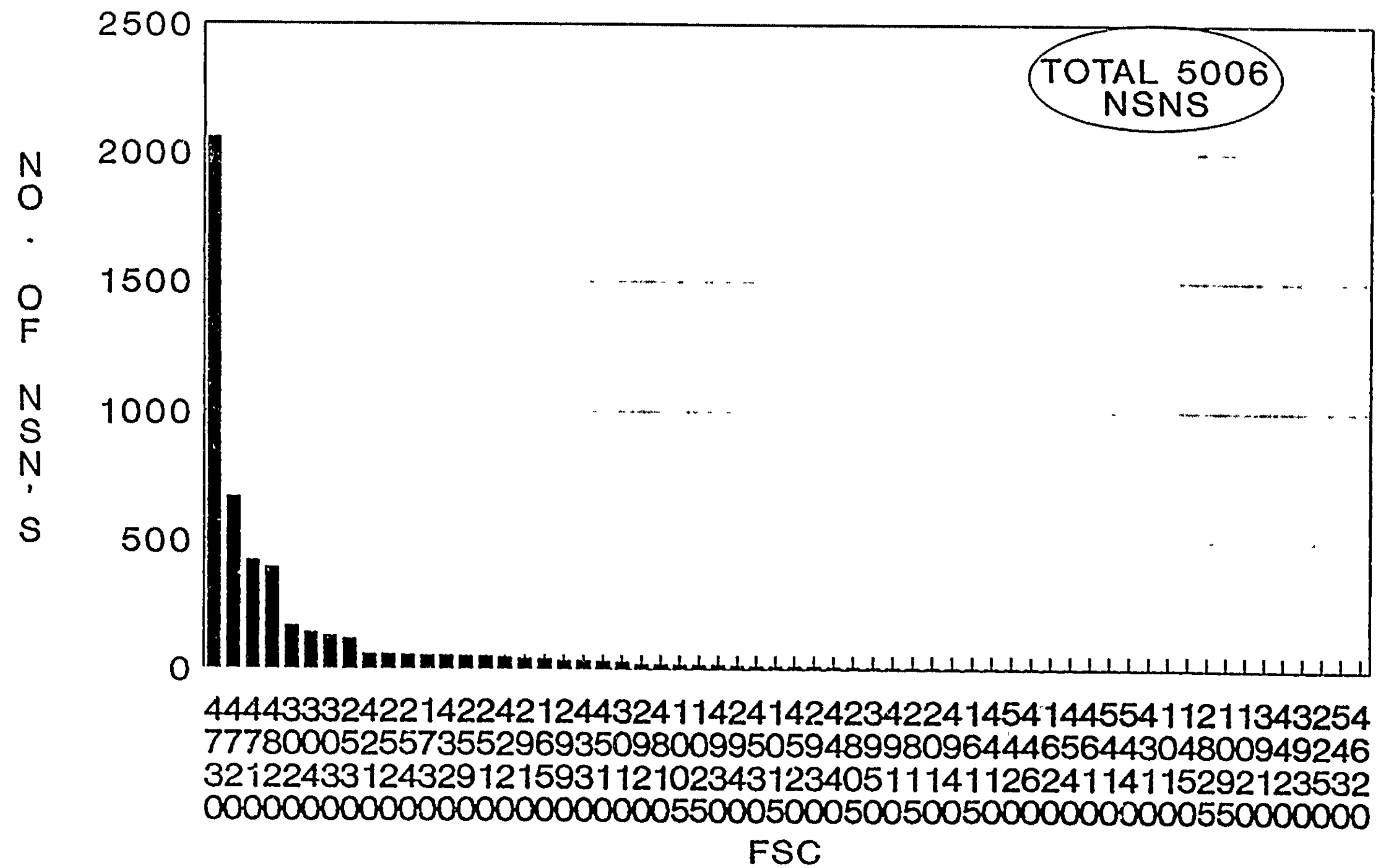

Table D-4
DLA's Laboratory Testing Program
Eligible NSN Frequency Count By Federal Supply Class (FSC): DCSC

FSC	NSN COUNT
4730	2058
4720	668
4710	422
4820	392
3020	168
3040	141
3030	128
2530	116
4210	57
2520	57
2540	55
1730	53
4320	52
2590	51
2510	50
4220	46
2910	41
1650	40
2990	34
4330	33
4510	30
3010	28
2920	19
4810	19
1005	18
1025	18
4930	17
2940	15
4530	14
1015	14
4520	14
2930	13
4440	12
2805	11
3950	10
4910	9
2815	9
2010	8
4940	6
1615	6
4410	6
5420	6
4460	6
1620	5
4540	5
4610	4
5410	4
5440	3
4310	2
1010	2
1450	2
2825	1
1095	1
1020	1
3910	1
4420	1
3930	1
2250	1
5430	1
4620	1
TOTAL	5,006

APPENDIX E

Eligible NSN Records Demographics

Table E-1

Candidate NSN Records Demographics for DGSC

By Frequency and Percent

Depot	Local	Central	DCMD North East	DCMD Mid-Atlantic	South	West	Total
DDRE	778	103	202	355	90	125	1653
	3.62	0.48	0.94	1.65	0.42	0.58	7.69
DDRW	1821	277	513	857	371	377	4216
	8.47	1.29	2.39	3.99	1.73	1.75	19.62
DDCO	308	109	67	166	106	55	811
	1.43	0.51	0.31	0.77	0.49	0.26	3.77
DDMT	1722	296	499	1100	479	466	4562
	8.01	1.38	2.32	5.12	2.23	2.17	21.23
DDRV	2359	403	813	1489	643	594	6301
	10.98	1.88	3.78	6.93	2.99	2.76	29.32
DDOU	1430	280	449	977	422	388	3946
	6.65	1.30	2.09	4.55	1.96	1.81	18.36
Total	8418	1468	2543	4944	2111	2005	21489
	39.17	6.83	11.83	23.01	9.82	9.33	100.00

Table E-2

Candidate NSN Records Demographics for DESC

By Frequency and Percent

Depot	Local	Central	DCMD North East	DCMD Mid-Atlantic	South	West	Total
DDRE	5425 13.73	327 0.83	784 1.98	1409 3.57	177 0.45	588 1.49	8710 22.04
DDRW	2446 6.19	192 0.49	512 1.30	780 1.97	88 0.22	320 0.81	4338 10.98
DDCO	1 0.00	0 0.00	1 0.00	1 0.00	0 0.00	0 0.00	3 0.01
DDMT	1 0.00	8 0.02	15 0.04	2 0.01	1 0.00	1 0.00	28 0.07
DDRV	9645 24.41	431 1.09	1724 4.36	2333 5.90	181 0.46	819 2.07	15133 38.29
DDOU	7236 18.31	324 0.82	1161 2.94	1800 4.55	144 0.36	643 1.63	11308 28.61
Total	24754 62.64	1282 3.24	4197 10.62	6325 16.00	591 1.50	2371 6.00	39520 100.00

Table E-3

Candidate NSN Records Demographics for DISC

By Frequency and Percent

Depot	Local	Central	DCMD North East	DCMD Mid-Atlantic	South	West	Total
DDRE	1509	157	939	1749	661	1000	6015
	3.41	0.35	2.12	3.95	1.49	2.26	13.58
DDRW	1751	177	1010	2017	786	1124	6865
	3.95	0.40	2.28	4.55	1.77	2.54	15.50
DDCO	3023	340	797	2337	2289	2621	11407
	6.83	0.77	1.80	5.28	5.17	5.92	25.76
DDMT	2981	335	1188	2471	1183	1389	9547
	6.73	0.76	2.68	5.58	2.67	3.14	21.56
DDRV	242	25	96	357	161	144	1025
	0.55	0.06	0.22	0.81	0.36	0.33	2.31
DDOU	2221	237	755	2154	1896	2166	9429
	5.01	0.54	1.70	4.86	4.28	4.89	21.29
Total	11727	1271	4785	11085	6976	8444	44288
	26.48	2.87	10.80	25.03	15.75	19.07	100.00

Table E-4

Candidate NSN Records Demographics for DCSC

By Frequency and Percent

Depot	Local	Central	DCMD North East	DCMD Mid-Atlantic	South	West	Total
DDRE	325	349	299	875	480	801	3129
	1.32	1.42	1.21	3.55	1.95	3.25	12.70
DDRW	396	553	473	1242	605	866	4135
	1.61	2.24	1.92	5.04	2.46	3.52	16.79
DDCO	403	533	353	1123	563	787	3762
	1.64	2.16	1.43	4.56	2.29	3.19	15.27
DDMT	525	748	449	1438	820	1388	5368
	2.13	3.04	1.82	5.84	3.33	5.63	21.79
DDRV	353	530	496	1174	489	713	3755
	1.43	2.15	2.01	4.77	1.98	2.89	15.24
DDOU	448	609	418	1317	680	1014	4486
	1.82	2.47	1.70	2.76	2.76	4.12	18.21
Total	2450	3322	2488	7169	3637	5569	24635
	9.95	13.48	10.10	29.10	14.76	22.61	100.00

APPENDIX

Prototype Stratified Sampling Plan Model

Table F-1

Stratified Sampling Matrix: DGSC
(Sampling for DCMDs)

CONFIDENCE LEVEL: 95%
PRECISION LEVEL : 0.08

	DCMD's						
Depot	Local	Central	North east	Mid-Atlantic	South	West	Total
DDRE	9	6	9	8	5	6	43
DDRW	21	17	22	18	19	19	116
DDCO	4	7	3	4	5	3	26
DDMT	20	18	22	24	24	23	131
DDRV	28	24	35	32	33	29	181
DDOU	17	17	19	21	21	19	114
Total	99	89	110	107	107	99	611

Table F-2

Stratified Sampling Matrix: DGSC
(Sampling for Depots)

CONFIDENCE LEVEL: 95%
PRECISION LEVEL : 0.08

	DCMD's						
Depot	Local	Central	North east	Mid-Atlantic	South	West	Total
DDRE	46	6	12	21	5	7	97
DDRW	44	7	13	21	9	9	103
DDCO	39	14	8	21	13	7	102
DDMT	32	5	9	20	9	9	84
DDRV	36	6	12	23	10	9	96
DDOU	33	6	10	22	10	9	90
Total	230	44	64	128	56	50	572

TABLE F-3

STRATIFIED SAMPLING PLAN: LOCALLY ADMINISTERED CONTRACTS: DGSC

DEPOT	STRATUM NUMBER	SAMPLE SIZE	NUMBER NON-CONF	SAMPLE PROPORT. (p)	WEIGHT (w)	EST OF VAR. (σ^2)	(1-f)	w2	VAR CAL	w*p
DDRE	778	5	2	0.4000	0.0924	0.0600	0.9936	0.0085	0.000509	0.036968
DDRW	1821	10	3	0.3000	0.2163	0.0233	0.9945	0.0468	0.001086	0.064897
DDCO	308	10	1	0.1000	0.0366	0.0100	0.9675	0.0013	0.000013	0.003659
DDMT	1722	10	2	0.2000	0.2046	0.0178	0.9942	0.0418	0.000740	0.040912
DDRV	2359	9	1	0.1111	0.2802	0.0123	0.9962	0.0785	0.000966	0.031137
DDOU	1430	5	1	0.2000	0.1699	0.0400	0.9965	0.0289	0.001150	0.033975
	8418	49	10		1.0000				0.004464	0.211548

SAMPLE EST OF VAR: 0.0045
STANDARD ERROR: 0.0668
SAMPLE AVE: 0.2115

MINIMUM SAMPLE SIZE

PREC LEVL	0.08
CONF LEVE	1.96
N':	100
n:	99

DISTRIBUTION OF SAMPLES

DDRE	9
DDRW	21
DDCO	4
DDMT	20
DDRV	28
DDOU	17
	99

TABLE F-4

STRATIFIED SAMPLING PLAN: DCMC CENTRAL

DEPOT	STRATUM NUMBER	SAMPLE SIZE	NUMBER NON-CONF	SAMPLE PROPORT. (p)	WEIGHT (w)	EST OF VAR. (σ^2)	(1-f)	w2	VAR CAL	w*p
DDRE	103	5	0	0.0000	0.0702	0.0000	0.9515	0.0049	0.000000	0
DDRW	277	6	1	0.1667	0.1887	0.0278	0.9783	0.0356	0.000968	0.031449
DDCO	109	8	2	0.2500	0.0743	0.0268	0.9266	0.0055	0.000137	0.018563
DDMT	296	8	1	0.1250	0.2016	0.0156	0.9730	0.0407	0.000618	0.025204
DDRV	403	10	3	0.3000	0.2745	0.0233	0.9752	0.0754	0.001715	0.082357
DDOU	280	5	1	0.2000	0.1907	0.0400	0.9821	0.0364	0.001429	0.038147
	1468	42	8		1.0000				0.004867	0.195720

SAMPLE EST OF VAR: 0.0049
STANDARD ERROR: 0.0698
SAMPLE AVE: 0.1957

MINIMUM SAMPLE SIZE

PREC LEVL	0.08
CONF LEVE	1.96
N':	94
n:	88

DISTRIBUTION OF SAMPLES

DDRE	6
DDRW	17
DDCO	7
DDMT	18
DDRV	24
DDOU	17
	89

TABLE F-5

STRATIFIED SAMPLING PLAN: DCMC NORTHEAST

DEPOT	STRATUM NUMBER	SAMPLE SIZE	NUMBER NON-CONF	SAMPLE PROPORT. (p)	WEIGHT (w)	EST OF VAR. (σ^2)	(1-f)	w2	VAR CAL	w*p
DDRE	202	5	1	0.2000	0.0794	0.0400	0.9752	0.0063	0.000246	0.015887
DDRW	513	6	2	0.3333	0.2017	0.0444	0.9883	0.0407	0.001788	0.067243
DDCO	67	8	3	0.3750	0.0263	0.0335	0.8806	0.0007	0.000020	0.00988
DDMT	499	11	2	0.1818	0.1962	0.0149	0.9780	0.0385	0.000560	0.035677
DDRV	813	10	3	0.3000	0.3197	0.0233	0.9877	0.1022	0.002356	0.09591
DDOU	449	5	1	0.2000	0.1766	0.0400	0.9889	0.0312	0.001233	0.035313
	2543	45	12		1.0000				0.006203	0.259910

SAMPLE EST OF VAR:	0.0062
STANDARD ERROR:	0.0788
SAMPLE AVE:	0.2599

MINIMUM SAMPLE SIZE

PREC LEVL	0.08
CONF LEVE	1.96
N':	115
n:	110

DISTRIBUTION OF SAMPLES

DDRE	9
DDRW	22
DDCO	3
DDMT	22
DDRV	35
DDOU	19
	110

TABLE F-6

STRATIFIED SAMPLING PLAN: DCMC MID-ATLANTIC

DEPOT	STRATUM NUMBER	SAMPLE SIZE	NUMBER NON-CONF	SAMPLE PROPORT. (p)	WEIGHT (w)	EST OF VAR. (σ^2)	(1-f)	w2	VAR CAL	w*p
DDRE	355	5	2	0.4000	0.0718	0.0600	0.9859	0.0052	0.000305	0.028722
DDRW	857	7	2	0.2857	0.1733	0.0340	0.9918	0.0300	0.001014	0.049526
DDCO	166	8	2	0.2500	0.0336	0.0268	0.9518	0.0011	0.000029	0.008394
DDMT	1100	10	1	0.1000	0.2225	0.0100	0.9909	0.0495	0.000491	0.022249
DDRV	1489	10	2	0.2000	0.3012	0.0178	0.9933	0.0907	0.001602	0.060235
DDOU	977	3	1	0.3333	0.1976	0.1111	0.9969	0.0391	0.004326	0.065871
	4944	43	10		1.0000				0.007765	0.234997

SAMPLE EST OF VAR:	0.0078
STANDARD ERROR:	0.0881
SAMPLE AVE:	0.2350

MINIMUM SAMPLE SIZE

PREC LEVL	0.08
CONF LEVE	1.96
N':	108
n:	106

DISTRIBUTION OF SAMPLES

DDRE	8
DDRW	18
DDCO	4
DDMT	24
DDRV	32
DDOU	21
	107

TABLE F-7

STRATIFIED SAMPLING PLAN: DCMC SOUTH

DEPOT	STRATUM NUMBER	SAMPLE SIZE	NUMBER NON-CONF	SAMPLE PROPORT. (p)	WEIGHT (w)	EST OF VAR. (σ^2)	(1-f)	w2	VAR CAL	w*p
DDRE	90	5	1	0.2000	0.0426	0.0400	0.9444	0.0018	0.000069	0.008527
DDRW	371	6	2	0.3333	0.1757	0.0444	0.9838	0.0309	0.001351	0.058582
DDCO	106	8	3	0.3750	0.0502	0.0335	0.9245	0.0025	0.000078	0.01883
DDMT	479	10	1	0.1000	0.2269	0.0100	0.9791	0.0515	0.000504	0.022691
DDRV	643	9	3	0.3333	0.3046	0.0278	0.9860	0.0928	0.002541	0.101532
DDOU	422	5	1	0.2000	0.1999	0.0400	0.9882	0.0400	0.001580	0.039981
	2111	43	11		1.0000				0.006122	0.250142

SAMPLE EST OF VAR: 0.0061
STANDARD ERROR: 0.0782
SAMPLE AVE: 0.2501

MINIMUM SAMPLE SIZE

PREC LEVL	0.08
CONF LEVE	1.96
N':	113
n:	107

DISTRIBUTION OF SAMPLES

DDRE	5
DDRW	19
DDCO	5
DDMT	24
DDRV	33
DDOU	21
	107

TABLE F-8

STRATIFIED SAMPLING PLAN: DCMC WEST

DEPOT	STRATUM NUMBER	SAMPLE SIZE	NUMBER NON-CONF	SAMPLE PROPORT. (p)	WEIGHT (w)	EST OF VAR. (σ^2)	(1-f)	w2	VAR CAL	w*p
DDRE	125	5	1	0.2000	0.0623	0.0400	0.9600	0.0039	0.000149	0.012469
DDRW	377	6	2	0.3333	0.1880	0.0444	0.9841	0.0354	0.001546	0.062677
DDCO	55	8	2	0.2500	0.0274	0.0268	0.8545	0.0008	0.000017	0.006858
DDMT	466	11	2	0.1818	0.2324	0.0149	0.9764	0.0540	0.000785	0.042258
DDRV	594	10	2	0.2000	0.2963	0.0178	0.9832	0.0878	0.001534	0.059252
DDOU	388	5	1	0.2000	0.1935	0.0400	0.9871	0.0374	0.001479	0.038703
	2005	45	10		1.0000				0.005510	0.222216

SAMPLE EST OF VAR: 0.0055
STANDARD ERROR: 0.0742
SAMPLE AVE: 0.2222

MINIMUM SAMPLE SIZE

PREC LEVL	0.08
CONF LEVE	1.96
N':	104
n:	99

DISTRIBUTION OF SAMPLES

DDRE	6
DDRW	19
DDCO	3
DDMT	23
DDRV	29
DDOU	19
	99

TABLE F-9

STRATIFIED SAMPLING PLAN: DDRE

DCMC	STRATUM NUMBER	SAMPLE SIZE	NUMBER NON-CONF	SAMPLE PROPORT. (p)	WEIGHT (w)	EST OF VAR. (σ^2)	(1-f)	w2	VAR CAL	w*p
LOCAL	778	10	3	0.3000	0.4707	0.0233	0.9871	0.2215	0.005102	0.141198
CENTRAL	103	8	2	0.2500	0.0623	0.0268	0.9223	0.0039	0.000096	0.015578
NORTHEAST	202	8	1	0.1250	0.1222	0.0156	0.9604	0.0149	0.000224	0.015275
MID-ATLAN	355	6	1	0.1667	0.2148	0.0278	0.9831	0.0461	0.001260	0.035794
SOUTH	90	5	1	0.2000	0.0544	0.0400	0.9444	0.0030	0.000112	0.010889
WEST	125	5	0	0.0000	0.0756	0.0000	0.9600	0.0057	0.000000	0
	1653	42	8		1.0000				0.006794	0.218734

SAMPLE EST OF VAR: 0.0068
STANDARD ERROR: 0.0824
SAMPLE AVE: 0.2187

MINIMUM SAMPLE SIZE

PREC LEVL	0.08
CONF LEVE	1.96
N':	103
n:	97

DISTRIBUTION OF SAMPLES

LOCAL	46
CENTRAL	6
NORTHEAST	12
MID-ATLAN	21
SOUTH	5
WEST	7
	97

TABLE F-10

STRATIFIED SAMPLING PLAN: DDRW

DCMC	STRATUM NUMBER	SAMPLE SIZE	NUMBER NON-CONF	SAMPLE PROPORT. (p)	WEIGHT (w)	EST OF VAR. (σ^2)	(1-f)	w2	VAR CAL	w*p
LOCAL	1821	10	3	0.3000	0.4319	0.0233	0.9945	0.1866	0.004329	0.129578
CENTRAL	277	8	2	0.2500	0.0657	0.0268	0.9711	0.0043	0.000112	0.016426
NORTHEAST	513	8	1	0.1250	0.1217	0.0156	0.9844	0.0148	0.000228	0.01521
MID-ATLAN	857	6	1	0.1667	0.2033	0.0278	0.9930	0.0413	0.001140	0.033879
SOUTH	371	5	1	0.2000	0.0880	0.0400	0.9865	0.0077	0.000306	0.0176
WEST	377	5	1	0.2000	0.0894	0.0400	0.9867	0.0080	0.000316	0.017884
	4216	42	9		1.0000				0.006430	0.230576

SAMPLE EST OF VAR: 0.0064
STANDARD ERROR: 0.0802
SAMPLE AVE: 0.2306

MINIMUM SAMPLE SIZE

PREC LEVL	0.08
CONF LEVE	1.96
N':	106
n:	103

DISTRIBUTION OF SAMPLES

LOCAL	44
CENTRAL	7
NORTHEAST	13
MID-ATLAN	21
SOUTH	9
WEST	9
	103

TABLE F-11

STRATIFIED SAMPLING PLAN: CDCO

DCMC	STRATUM NUMBER	SAMPLE SIZE	NUMBER NON-CONF	SAMPLE PROPORT. (p)	WEIGHT (w)	EST OF VAR. (σ^2)	(1-f)	w2	VAR CAL	w*p
LOCAL	308	10	3	0.3000	0.3798	0.0233	0.9675	0.1442	0.003256	0.113933
CENTRAL	109	8	2	0.2500	0.1344	0.0268	0.9266	0.0181	0.000448	0.0336
NORTHEAST	67	8	1	0.1250	0.0826	0.0156	0.8806	0.0068	0.000094	0.010327
MID-ATLAN	166	6	2	0.3333	0.2047	0.0444	0.9639	0.0419	0.001795	0.068229
SOUTH	106	5	1	0.2000	0.1307	0.0400	0.9528	0.0171	0.000651	0.026141
WEST	55	5	1	0.2000	0.0678	0.0400	0.9091	0.0046	0.000167	0.013564
	811	42	10		1.0000				0.006411	0.265793

SAMPLE EST OF VAR: 0.0064
STANDARD ERROR: 0.0801
SAMPLE AVE: 0.2658

MINIMUM SAMPLE SIZE

PREC LEVL	0.08
CONF LEVE	1.96
N':	117
n:	102

DISTRIBUTION OF SAMPLES

LOCAL	39
CENTRAL	14
NORTHEAST	8
MID-ATLAN	21
SOUTH	13
WEST	7
	102

TABLE F-12

STRATIFIED SAMPLING PLAN: DDMT

DCMC	STRATUM NUMBER	SAMPLE SIZE	NUMBER NON-CONF	SAMPLE PROPORT. (p)	WEIGHT (w)	EST OF VAR. (σ^2)	(1-f)	w2	VAR CAL	w*p
LOCAL	1722	16	3	0.1875	0.3775	0.0102	0.9907	0.1425	0.001434	0.070775
CENTRAL	296	12	2	0.1667	0.0649	0.0126	0.9595	0.0042	0.000051	0.010814
NORTHEAST	499	8	1	0.1250	0.1094	0.0156	0.9840	0.0120	0.000184	0.013673
MID-ATLAN	1100	11	2	0.1818	0.2411	0.0149	0.9900	0.0581	0.000856	0.04384
SOUTH	479	5	1	0.2000	0.1050	0.0400	0.9896	0.0110	0.000436	0.021
WEST	466	8	1	0.1250	0.1021	0.0156	0.9828	0.0104	0.000160	0.012769
	4562	60	10		1.0000				0.003121	0.172870

SAMPLE EST OF VAR: 0.0031
STANDARD ERROR: 0.0559
SAMPLE AVE: 0.1729

MINIMUM SAMPLE SIZE

PREC LEVL	0.08
CONF LEVE	1.96
N':	86
n:	84

DISTRIBUTION OF SAMPLES

LOCAL	32
CENTRAL	5
NORTHEAST	9
MID-ATLAN	20
SOUTH	9
WEST	9
	84

TABLE F-13

STRATIFIED SAMPLING PLAN: DDRV

DCMC	STRATUM NUMBER	SAMPLE SIZE	NUMBER NON-CONF	SAMPLE PROPORT. (p)	WEIGHT (w)	EST OF VAR. (σ^2)	(1-f)	w2	VAR CAL	w*p
LOCAL	2359	10	3	0.3000	0.3744	0.0233	0.9958	0.1402	0.003257	0.112316
CENTRAL	403	8	2	0.2500	0.0640	0.0268	0.9801	0.0041	0.000107	0.01599
NORTHEAST	813	8	1	0.1250	0.1290	0.0156	0.9902	0.0166	0.000258	0.016128
MID-ATLAN	1489	6	1	0.1667	0.2363	0.0278	0.9960	0.0558	0.001545	0.039385
SOUTH	643	5	1	0.2000	0.1020	0.0400	0.9922	0.0104	0.000413	0.020409
WEST	594	5	0	0.0000	0.0943	0.0000	0.9916	0.0089	0.000000	0
	6301	42	8		1.0000				0.005580	0.204228

SAMPLE EST OF VAR: 0.0056
STANDARD ERROR: 0.0747
SAMPLE AVE: 0.2042

MINIMUM SAMPLE SIZE

PREC LEVL	0.08
CONF LEVE	1.96
N':	98
n:	96

DISTRIBUTION OF SAMPLES

LOCAL	36
CENTRAL	6
NORTHEAST	12
MID-ATLAN	23
SOUTH	10
WEST	9
	96

TABLE F-14

STRATIFIED SAMPLING PLAN: DDOU

DCMC	STRATUM NUMBER	SAMPLE SIZE	NUMBER NON-CONF	SAMPLE PROPORT. (p)	WEIGHT (w)	EST OF VAR. (σ^2)	(1-f)	w2	VAR CAL	w*p
LOCAL	1430	16	3	0.1875	0.3624	0.0102	0.9888	0.1313	0.001319	0.067949
CENTRAL	280	5	2	0.4000	0.0710	0.0600	0.9821	0.0050	0.000297	0.028383
NORTHEAST	449	8	1	0.1250	0.1138	0.0156	0.9822	0.0129	0.000199	0.014223
MID-ATLAN	977	11	2	0.1818	0.2476	0.0149	0.9887	0.0613	0.000902	0.045017
SOUTH	422	5	1	0.2000	0.1069	0.0400	0.9882	0.0114	0.000452	0.021389
WEST	388	9	1	0.1111	0.0983	0.0123	0.9768	0.0097	0.000117	0.010925
	3946	54	10		1.0000				0.003285	0.187886

SAMPLE EST OF VAR: 0.0033
STANDARD ERROR: 0.0573
SAMPLE AVE: 0.1879

MINIMUM SAMPLE SIZE

PREC LEVL	0.08
CONF LEVE	1.96
N':	92
n:	90

DISTRIBUTION OF SAMPLES

LOCAL	33
CENTRAL	6
NORTHEAST	10
MID-ATLAN	22
SOUTH	10
WEST	9
	90